

MI-0172

Chromaticity Adjustment System for the Recycler

S. D. Holmes
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The Recycler Ring long combined function magnets incorporate a built in sextupole component that is designed to reduce the chromaticity of the ring to -5 in each plane. The purpose of this note is to specify a sextupole correction system that will allow adjustment of the operational chromaticity to +5 in each plane.

The contribution to the chromaticity from two families of sextupoles, one denoted "F" and one denoted "D", is

$$\begin{cases} \Delta\xi_H = A(B''L)_F + B(B''L)_D \\ \Delta\xi_V = C(B''L)_F + D(B''L)_D \end{cases}$$

where $(B''L)_F$ and $(B''L)_D$ are the strengths of the sextupoles within each family and the coefficients A,B,C, and D are given by:

$$\begin{cases} A = \frac{1}{4\pi(B\rho)_F} \sum \beta_H \eta_H & B = \frac{1}{4\pi(B\rho)_D} \sum \beta_H \eta_H \\ C = \frac{1}{4\pi(B\rho)_F} \sum \beta_V \eta_H & D = \frac{1}{4\pi(B\rho)_D} \sum \beta_V \eta_H \end{cases}$$

Here $(B\rho)$ is the magnetic rigidity and the sums are over all elements within a given family as indicated. The coefficients are calculated assuming that all sextupoles within the F family are at focusing gradient magnets ($\beta_H=55$ m, $\beta_V=11$ m, $\eta=2$ m) and within the D family are at defocusing gradient magnets ($\beta_H=11$ m, $\beta_V=55$ m, $\eta=1$ m). The required total sextupole strength within a given family can then be calculated and is given in Table 1.

Table 1: Required sextupole strengths to provide a change in chromaticity as indicated in the left two columns. F and D refer to the two families and $N(B''L)$ is the number of magnets in the family times the strength of each magnet in the family.

$\Delta\xi_H$	$\Delta\xi_V$	$N_F(B''L)_F$ (kG/m)	$N_D(B''L)_D$ (kG/m)
+10	0	354	-708
0	+10	71	-141
+10	+10	424	-849

The Main Injector sextupole can run DC at a current of 180 A, and provides a total strength of $B''L=729$ kG/m at this current. The strength indicated in Table 1 can be more than accommodated by providing two Main Injector sextupoles in each family.

Conclusion

It is proposed to provide chromaticity adjustment through two families of sextupoles in the Recycler Ring. Each family should consist of two Main Injector sextupoles run in series with the same polarity. The two sextupole magnets in a family should be separated by 180° of phase advance (two cells) in order to minimize third order resonance driving terms. A power supply capability of 100 A would provide adjustment up to $(\xi_H, \xi_V)=(+5, +5)$, while a 150 A capability would allow adjustment up to $(\xi_H, \xi_V)=(+9, +9)$.